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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/808,168	03/24/2004	Haowen Bu	TI 37782	4831
23494	7590	09/15/2005	EXAMINER	
TEXAS INSTRUMENTS INCORPORATED P O BOX 655474, M/S 3999 DALLAS, TX 75265			AHMADI, MOHSEN	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 09/15/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/808,168

Applicant(s)

BU ET AL.

Examiner

Mohsen Ahmadi

Art Unit

2812

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) 11-13 is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-10 and 14-23 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date ____.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date ____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: ____.

DETAILED ACTION

The application of Haowen Bu et al. For a "Semiconductor Device Having a Fully Silicided Gate Electrode and Method of Manufacture Therefor" filed March 24, 2004 has been examined.

Restrictions Requirement

Restriction to one of the following inventions is required under 35 U.S.C. 121:

- I. Claims 1-10 and 14-23, drawn to method, classified in class 438, subclass 682.
- II. Claims 11-13, drawn to device, classified in class 257, subclass 1+.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In this case, the method claims can be used to make a materially different device, such as one that has a protective layer, which is not required by the device claims.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group II, restriction for examination purposes as indicated is proper.

During a telephone conversation with Peter McLarty on August 24, 2005 a provisional election was made without traverse to prosecute the invention of Group I claims 1-10 and 14-23. Affirmation of this election must be made by applicant in replying to this Office action. Claims 11-13 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2, 14 and 15 are rejected under 35 U.S.C. 102(b) as being anticipated by Yu (US Pat. 6,326,291).

The present claims generally require a method for manufacturing a semiconductor device, comprising: forming a protective layer over a polysilicon gate electrode located over a substrate to provide a capped polysilicon gate electrode; forming source/drain regions in substrate proximate capped polysilicon gate electrode; removing protective layer using an etchant; siliciding polysilicon gate electrode to form a silicided gate electrode; and siliciding source/drain regions. Claims 14 and 15 further require the formation of an interconnection.

Regarding claim 1, Figure 2 of Yu discloses a semiconductor substrate 208 comprising a polysilicon gate electrode 212, and a capping layer 216 which is comprised of a hardmask material such as siliconoxynitride (SiON) which is disposed over the top of the polysilicon gate structure 212. Yu discloses a method of forming source 204 and drain 202 regions in the substrate proximate the capped polysilicon gate electrode. Yu discloses a method of removing protective layer using an etchant (See col 5, lines 43-44). Yu discloses a method of siliciding the polysilicon gate (silicidation metal) to form a silicided gate (See col 5, lines 60-63). Yu also discloses a method of siliciding source and drain regions that comprise of a metal silicide such as nickel silicide (NiSi_2) (See col 5, lines 16-18).

Regarding claim 14, Figure 2 of Yu discloses a method for forming semiconductor devices 200 over a substrate 208 including; a polysilicon gate electrode 212 and a capping layer 216 comprised of a hardmask material such as siliconoxynitride (SiON) which is disposed over the top of the polysilicon gate structure 212. Yu discloses a method of forming source 204 and drain 202 regions in substrate

Art Unit: 2812

proximate capped polysilicon gate electrode. Yu discloses a method of removing protective layer using an etchant (See col 5, lines 43-44). Yu discloses a method of siliciding the polysilicon gate (silicidation metal) to form a silicided gate (See col 5, lines 60-63). Yu discloses a method of siliciding source and drain regions that comprised of a metal silicide such as nickel silicide (NiSi_2) (See col 5, lines 16-18). Figure 10 and 11 of Yu also discloses formation of interconnect to the gate silicide. A second dielectric layer 250 is deposited over the gate silicide 240 and over the first dielectric layer 230. A gate interconnect 252 is formed on the second dielectric layer 250, and the gate interconnect 252 is conductively coupled to the gate silicide 240 with a gate via 254. In addition, a drain interconnect 256 is formed on the second dielectric layer 250, and the drain interconnect 256 is conductively coupled to the drain silicide 220 with a drain via 258. Similarly, a source interconnect 260 is formed on the second dielectric layer 250, and the source interconnect 260 is conductively coupled to the source silicided 222 with a source via 262 (See col 6 and 7, lines 61-67 and 1-9).

Regarding claim 2 and 15, Figure 3 of Yu discloses a method of forming a silicide blocking layer over source and drain regions prior to siliciding polysilicon gate electrode. This dielectric layer 230 is comprised of a dielectric material such as silicon dioxide (SiO_2) (See col, 5 lines 25-30).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

Art Unit: 2812

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 3, 4, 5, 16, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yu (US Pat. 6,326,291) in view of Chang (US Pat. 6,794,313).

Yu is relied upon as discussed above.

Regarding claim 3, 4, 5, 16, 17 and 18 Yu discloses all of the claimed features as stated above except for growing a silicide blocking layer using a dry oxidation process and low temperature radical oxidation or plasma oxidation process, and the thickness of blocking layers.

Regarding claims 3 and 16 Chang discloses a silicon dioxide layer which is formed over the surface of substrate, where the silicon dioxide, thermally grown in an oxygen-steam ambient at a temperature between 800 and 1,000 degrees C using a dry oxidation process (See col, 3 lines 48-53).

Regarding claims 4 and 17 Chang discloses a methods of oxidation that can be used for the creation of silicon dioxide in a dry oxygen and anhydrous hydrogen chloride in an atmospheric or low pressure environment or in a low temperature, high pressure environment and the like (See col, 3 lines 48-64).

Regarding claims 5 and 18 Chang discloses the thickness ranging for silicon dioxide are about 30 to 300 Angstrom (See col, 3 lines 53-54).

As Yu calls for the formation of silicon dioxide, it would have been obvious to one of ordinary skill in the art, at the time of invention, to use the method as disclosed by Chang for forming the silicon dioxide layer. The selection of the reactor parameters for

forming a silicon dioxide layer would have been *prima facie* obvious in view of the teaching of Chang.

Claims 6 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yu (US Pat. 6,326,291) in view of Chan et al. (US Pat. 2005/0179098).

Yu is relied upon as discussed above. Yu discloses the use of a hardmask layer such as siliconoxynitride as the protective layer.

However Yu does not disclose silicon nitride as the protective layer.

Regarding claims 6 and 19 Chan et al. discloses a hard mask layer such as silicon nitride can be selectively etched with respect to the polysilicon gate, and is deposited by a CVD process to protect the top surface of the polysilicon gate (See page, 2 paragraph [0024]).

It would have been obvious to one of ordinary skill in the art, at the time of invention, to use a silicon nitride hardmask layer as disclosed by Chan et al. to protect the polysilicon gate as disclosed by Yu for their known benefit of protection of the underneath layer. Yu broadly calls for silicon oxynitride and other hardmask materials, and Chan discloses that silicon nitride is a known hardmask layer. Therefore, a *prima facie* case of obviousness is established.

Claims 7, 8, 20 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yu (US Pat. 6,326,291) in view of Chan et al. (US Pat. 2005/0179098) further in view of Moore et al. (US Pat. 20010034129).

Yu and Chan et al. are relied upon as discussed above and discloses all of the claimed features as stated above except for the sidewall spacer including nitride, the

different nitride composition of the spacer and the protective layer, and the nitride carbon content of 5-10%.

Furthermore, Chan et al. teaches nitride is a preferred insulating material for a gate sidewall and as Yu teaches any insulating material may be used. Regarding claims 7 and 20 Chan et al. discloses the spacers comprise an insulator material, such as oxide or nitride. Preferably, the spacers comprise silicon nitride are formed adjacent capped polysilicon gate electrode (See page, 2 paragraph [0028]).

It would have been obvious to one of ordinary skill in the art, at the time of invention, to use the method of Chan et al. to form the spacer containing nitride because as Chan et al. teaches nitride is a preferred insulating material for a gate sidewall and as Yu teaches any insulating material may be used. Furthermore it has been held that the selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in Sinclair & Carroll Co. v. interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945). See also In re Leshin, 227 F.2d 197, 125 USPQ 416 (CCPA 1960).

Regarding claim 8 and 21, Yu discloses all of the claimed features as stated above except for the nitride layer has from about 5% to about 10% carbon content.

Regarding claims 8 and 21 Moore et al. discloses an etch stop layer for example silicon nitride to form the substrate where silicon nitride layer having from 2% to about 20% carbon incorporated (by weight) (See page, 4 paragraph [0045]).

It would have been obvious to one of ordinary skill in the art, at the time of invention, to use nitride layer that has about 5% to about 10% carbon content as

disclosed by Moore et al. to form the sidewall spacer containing nitride as disclosed by Yu and Chan et al. for their known benefit selectivity when etching for integration or interconnects (See page, 4 paragraph [0046]). It also has been held that the selection of a known material based on its suitability for its intended use supported a *prima facie* obviousness determination in Sinclair & Carroll Co. v. interchemical Corp., 325 U.S. 327, 65 USPQ 297 (1945). See also In re Leshin, 227 F.2d 197, 125 USPQ 416 (CCPA 1960). Moreover, the formation of the spacer using the nitride of Moore et al. would result in a different chemical composition than the nitride which is used as the blocking layer as disclosed by Yu and Chan et al. as Chan et al. does not specify the carbon content of its nitride layer.

Claims 9 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yu is relied upon as discussed above. (US Pat. 6,326,291).

Yu discloses in their invention the method of siliciding the source and drain regions, but do not discloses the method wherein the silicide extends under a portion of gate sidewall spacers.

However Yu discloses in the prior art the method where silicided source and drain regions 114 and 116 are extended under a portion of gate sidewall spacers 113 located adjacent to silicided gate electrode 112. See figure 1.

It would have been obvious to one of ordinary skill in the art, at the time of invention, to form extending under a portion of gate sidewall spacers located adjacent silicided gate electrode because it is disclosed in the Yu et al reference as an unpreferred embodiment. Unpreferred embodiments must be considered in determining

obviousness. See *In re Burckel*, 201 USPQ 67 (1979). Moreover, a reference is not limited to preferred embodiments. See *In re Boe*, 148 USPQ 507 (CCPA 1966). The use of a structure disclosed in the prior art would be within the level of one of ordinary skill in the art.

Claims 10 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yu (US Pat. 6,326,291) in view of Chan et al. (US Pat. 2005/0179098).

Yu is relied upon as discussed above.

Regarding claim 10 and 23 Yu discloses all of the claimed features as stated above except for the thickness of protective layer.

Regarding claims 10 and 23 Chan et al. discloses a method where the protective layer, silicon nitride has a thickness ranging from about 100 angstroms to about 1,000 angstroms (See page, 2 paragraph [0024]).

It would have been obvious to one of ordinary skill in the art, at the time of invention, to use the thickness ranges as disclosed by Chan et al. in the protective layer as disclosed by Yu for their known benefit in protecting silicide layers. The examiner notes both references are drawn to analogous art, the protection of silicide layers using hard mask nitride and therefore a *prima facie* cases of obviousness is established.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mohsen Ahmadi whose telephone number is 1-571-272-5062. The examiner can normally be reached on Mon-Thur 8:00am-6:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael Lebentritt can be reached on 1-571-272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MA
September

Mohsen Ahmadi

Michael Lebentritt
MICHAEL LEBENTRITT
SUPERVISORY PATENT EXAMINER